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Debt and International Finance

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Measuring the Risk of Default in Six Highly Indebted Countries

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and
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The risk that the debtor country will default on its external debt may be significantly decreased by a debt-reduction operation, by a reduction in international interest rates, and by changes in the country's willingness to pay.

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This paper — a product of the Debt and International Finance Division, International Economics Department — is part of a larger effort in the department to investigate the benefits and costs to debtor countries and creditors of voluntary, market-based debt and debt service reduction arrangements. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Sheilah King-Watson, room S8-040, extension 31047 (June 1992, 21 pages).

The price of debt on the secondary market reflects the risk that the debtor country might default on its external debt.

Using the option-pricing theory, Chesney and Morisset identify the factors that influenced the risk of default in six highly indebted countries from 1986 to 1990.

In particular, they provide a measure of the debtor countries' willingness to pay. They identify the parameters of the stochastic process followed by this variable, so this approach can be used to predict the future price of debt.

Their model also emphasizes that a debt-reduction operation may lead to a significant increase in the price of debt on the secondary market. This effect appears to be linked to the initial stock of external debt, as suggested by the "debt overhang" hypothesis.

Finally, Chesney and Morisset show empirically that a country's *willingness* to pay is significantly influenced by changes in indicators of the country's *ability* to pay (for example, by an increase in reserves or in GDP growth), and by exogenous events such as the increase in commercial banks' loan reserves in mid-1987 or the Brady Plan announcement in 1989.

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SUMMARY

1. The major differences between domestic and international debt is that the former are legal obligations, enforceable in courts and that domestic debtors who cannot meet their obligations have the option of filling for bankruptcy. In contrast, repayment of international debt depends largely on the borrower's beliefs about the lender's resolve to penalize a disruption of repayment. Along these lines, three simples rules can be distinguished: First, the debtor country will reimburse its debt if the payment required to offset the penalties - applied in case of default - is higher than the debt itself. Second, the debtor country will only pay a fraction of its total debt-service if the payment required to offset the penalties is positive but lower than the face value of the debt. The third possibility is that the debtor country will call a total default on its external debt because the economic and political benefits in case of full default would be higher than the sanctions applied by the lenders.

2. The major problem related to this approach is that the willingness to pay and potential penalties are unobservable variables. The idea in this study is to use the information on the secondary market of the price of debt to obtain a measurement of these variables. Indeed, the market value of the debt can be viewed as the result of the simple rules described above. The country examines the alternative to pay according to the values of its potential payments and its willingness to pay, thereby determining the market value of the debt. Using the option-pricing theory, this study identifies explicitly the factors driving the price of debt on the secondary market : the willingness to pay, the interest rate, the maturity and the volume of debt.

3. The approach is applied to six highly indebted countries - Argentina, Brazil, Chile, Mexico Poland and Venezuela - in order to measure their willingness to pay over the last four years. The results indicate that the willingness to pay were quite volatile in all countries. Interestingly, the model provides us the probability of full and partial default of the debtor countries. Moreover, the approach can be used to forecast the price of debt. The comparison between the observed and the estimated price of debt for

the first quarter of 1991 indicates that the model predicts relatively well the future price of the debt.

4. The study examines the consequences of three different policies on the price of debt: (i) A reduction in the existing stock of debt, (ii) an extension of the maturity, and (iii) a reduction in the interest rates. If the impact of a debt-reduction was ambiguous in the theoretical model, reflecting in that sense the opposing views which currently exist in the literature, all simulation results indicate that the effect of a decline in the stock of external debt would increase the price of debt on the secondary market. Specifically, the model demonstrates that this positive impact is closely related to the initial levels of debt and of the willingness to pay of the debtor country. While the first point indicates that the "debt overhang" is more likely to be reduced if the existing debt is large, the second suggests that the benefit of a debt-reduction operation will be greater whether the debtor country's willingness is high enough to attract new financing. Concerning, the impact of an increase in maturity, the model indicates that such policy will generally lead to a decline in the price of debt because the willingness to pay is likely to decrease over time. In contrast, the price of debt is positively influenced by a decline in the rate of interest. The dramatic decline in the Libor rate explains to a large extent the higher prices of debt observed on the secondary market since the beginning of 1991.

5. In the final part of the study, the responsiveness of the willingness to pay to three classes of factors has been estimated. First, we tested the hypothesis that the willingness to pay are influenced by the debtor country's capacity to pay. Identification of such domestic influences, if any, on the willingness to pay may confirm that debtor countries economic situation is partly reflected in the price of debt. Second, the impact of particular events on the willingness to pay may be significant since the number of potential buyers and sellers are small in the secondary market. Third, since the economic conditions existing in the creditor country can influence the bargaining process between the debtor and the creditors, we

estimated the impact of changes in the creditor's behavior on the willingness to pay of the debtor country.

The major policy conclusions of the exercise are the following :

(1) A debt-reduction operation is likely to influence positively the price of debt on the secondary market. Particularly, if the existing stock of debt is high and if the environment is favorable enough to attract new financing.

(2) An increase in GDP of the debtor country may exert a significative impact on the its willingness to pay external debt. An improvement in economic conditions of the debtor country can therefore enhance payments of interest on external debt. This suggests that a strategy relying on debtor country's economic growth may be more efficient than the implementation of penalties for default.

(3) Changes in creditor's behavior may affect the debtor country's willingness to pay. While the Brady announcement produced a favorable impact on the willingness to pay, the influence of announcements regarding loans reserves by commercial banks was negative.

Introduction

The recent literature on country risk emphasizes that a country's prospect of paying its future debt-service depends essentially on its creditworthiness, which refers not only to a country's ability but also to its willingness to pay. In an important paper, Gersovitz, Eaton and Stiglitz (1986) argued that countries virtually always have sufficient resources to repay their loans [2]. Furthermore, temporary liquidity problems should not cause payments problems either, so long as the problem is correctly perceived by the creditors. Creditors could simply make additional temporary loans or lengthen maturities to overcome a temporary liquidity problem. Consequently, a lack of creditworthiness is more than just a problem of insolvency and illiquidity. The main problem faced when attempting to assess creditworthiness is the measure of the country's willingness to repay which is not directly observable. Indeed, one should be able to identify the internal or external enforcement mechanisms which reward a country for paying its debt and penalize it for default.

The purpose of this paper is to develop a simple approach to measure the willingness to pay of a number of debtor countries. To the extent that the secondary market of the price of debt is efficient (in the sense that all new information is quickly assimilated), the price of LDCs debt reflects the present value of rationally expected future debt-service payments. Moreover, as suggested by Borensztein and Pennacchi (1990), the price of debt should be related to an unobservable variable that determines debtor country repayment to private banks. This variable expresses the willingness to pay of the debtor country and should be the result of a complicated bargaining process which is itself affected by factors such as political and economic shocks. By using the option-pricing theory we are able to identify this variable and to provide some estimate of its value for a sample of highly indebted countries over the 1986-1990 period. In addition, since the parameters of the stochastic process

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[2] "In a formal sense, insolvency is not really an issue in lending to foreign governments. The debt of a country in almost all instances is less than the value of the assets owned by national and government of the country" (p.484).

followed by this variable are identified, this procedure can be used to predict the evolution of the price of debt.

The main advantage of this approach is that the country's risk of default (reflected in the price of debt) is defined without any a priori assumptions regarding the variables which affect the country's willingness to pay. In such a case, it is interesting to determine the principal factors exerting a significant impact on the willingness to pay. From a policy perspective, it is important to ask if a change in GDP growth or in international reserves of the debtor country or both can affect its willingness to pay. If higher GDP growth leads to a significative increase in the willingness to pay, there will be an additional channel through which external debt service payments may be increased in the medium-term. Indeed, this result would suggest that a strategy relying on debtor country's economic growth may be more efficient than the implementation of penalties for default. In short, this paper can be viewed as an attempt to reconcile (i) the recent theory of country risk (see Gersovitz, Eaton and Stiglitz (1986); (ii) the option theory applied to the price of debt on secondary market (see Claessens and Van Wijnbergen (1990), Cohen (1989) or Bartolini and Dixit (1990) and (iii) empirical studies on LDCs creditworthiness.

The paper proceeds as follows. Section 1 presents the analytical framework based on the option theory to assess the relationship between the price of debt and the willingness to pay of the debtor country. In section 2, we apply this approach to a sample of 6 developing countries. We present the empirical results and discuss the impact of debt-reduction polices and changes in interest rates on the price of debt. In section 3, we attempt to identify empirically the principal factors which affect the country's creditworthiness. Finally, section 4 contains our conclusions.

1. A Theoretical Approach : A Measure of the Willingness to Pay

The borrower's willingness to pay its external debt depends critically

on its beliefs about the lender's resolve to penalize a disruption of repayment. Most authors stress two forms of penalties. First, the probability of default is related to the eventual loss of future access to capital markets (Eaton and Gersovitz (1981)) and, second, a country will choose not to repudiate its debt only if the lenders can impose direct sanctions such as the elimination of trade credits or seizure of debtor assets held in the creditor countries (e.g. Bulow and Rogoff (1989)). The motivation for repayment is, therefore, the penalties that the creditors are able to impose. If the implementation of penalties are clearly damaging to the debtor country, the lenders may also be reticent to use their limited enforcement power. As a matter of fact, the use of sanctions suffers from a time consistency problem[3] and, above all, the banks prefer some repayment as opposed to none[4]. Fernandez and Rosenthal (1990) argue that, under these circumstances, the debtor country and the creditors may attempt to renegotiate the repayment stream.

In this paper, we assume that the debtor country and the creditors engage in such a bargaining process. Both agents negotiate an agreement on the amount that the debtor country should pay so that the lenders will not apply penalties. The creditors are likely to prefer this approach because the implementation of the sanctions will induce no monetary gains and, eventually, will be costly. Similarly, the debtor country will favor this payment because it is always lower than the cost of the penalties. In equilibrium, the amount of the payment will reflect the willingness to pay of the debtor country and according to this amount, the indebted country will choose to (i) repay its total debt, (ii) call a partial default or (iii) call a full default. In a two simple periods framework (current and maturity periods), we can write the following equations :

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[3] For example, creditors may be enforced to write down the value of the debt on their books to zero in case of sanctions. A result which creditor banks want to avoid (see Hellwig (1986)).

[4] The seizure of the debtor country's assets abroad do not appear a potential risk according to Wakeman-Linn (1989).

no default if $X_\tau > D_\tau$

partial default if $D_\tau > X_\tau > 0$

full default if $X_\tau < 0$

where X_τ is defined as the debtor country's willingness to pay, D_τ the face value of external debt at maturity and τ the maturity period.

These three simple rules can be illustrated as follows. First, the debtor country will reimburse its debt if the payment required to offset the penalties - applied in case of default - is higher than the debt itself. The reimbursement is less expensive than the required payment or the costs of the penalties. Second, if the payment is positive but lower than the face value of the debt, the country will choose to pay rather than to reimburse totally its external debt. This corresponds to the case of partial default in the sense that the debtor country will only pay a fraction of its total debt-service. The third possibility is that the willingness to pay is negative or, in other terms, the country should receive money in order to avoid a penalty by its lenders. This may arise if the economic and political benefits in case of full default are higher than the sanctions applied by the lenders. In this case, the debtor country will call a total default on its external debt.

The major problem related of this approach is that the willingness to pay (X_τ) is an unobservable variable. The willingness to pay depends on the bargaining outcome between the creditors and the debtor country which, as discussed by Fernandez and Rosenthal (1990), is generally very sensitive to the particular specifications of the institutional structure in which it is embedded. As suggested in the introduction, the idea in this paper is to use the information on the secondary market of the price of debt to obtain a measurement of this variable. More precisely, assuming that the price of debt reflects the repayment prospects of the borrowers countries, we suggest that these prospects are influenced to a large extent by the debtor country's willingness to pay. In continuous time, we can represent this assumption by the following expression:

(1) $V_t = D_t[p(X_\tau > D_\tau)] + \exp(-r\tau)E(X_\tau \, 1_{0 < X_\tau < D_\tau})$

where V_t is the market value of the debt on the secondary market, t the current period, r the actualization rate, τ the maturity of the external debt, and 1 the function which equals one over the interval 0 and D_τ and 0 elsewhere. The price of debt is therefore defined as the probability V_t/D_t.

Equation (1) states that the market value of the debt on the secondary market is the expected value of the future repayments. The market value equals the value of a contingent claim where the willingness to pay (X_τ) is the underlying asset. The debtor country examines continuously the possibility to call a default according to the value of its potential payments and the value of the variable X_τ. While the first term in parenthesis is the probability that the debtor country will reimburse its debt on the current period, the second term illustrates the probability that the debtor country will call a partial default. We do not write the probability of full default because, in this case, the payment will be equal to 0. However, unlike most authors using the option theory, we consider the possibility that the debtor country may call a total default on its external debt[5].

Let us assume that the willingness to pay is a random variable that fluctuates over time in a stochastic manner[6]. Moreover, for analytical simplicity, we suppose the process depends on a Brownian motion :

(2) $dX_t = \mu dt + \sigma dz$

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[5]For example, Claessens and Van Wijnbergen (1990) or Bartolini and Dixit (1990) consider that the payment of the country depends on its foreign exchange availability. In such case, these authors only assume a partial default.

[6] In recent papers, the price of debt is assumed to follow a Brownian motion. But, since the secondary market is relatively thin, the price of debt is likely to be influenced by exogenous shocks (e.g. changes in LIBOR) and has no tendency to revert to a long-run average. We consider more realistic the assumption that the debtor country's willingness to pay is a Brownian motion because the effects of such shocks is controlled for.

where $(z_t)_{t\in R}$ a Brownian motion, μ the drift and σ the volatility of the process. Note that this process includes the prospect that the variable X_t can be negative as discussed above.

Given equation (2) and after some manipulations, we can rewrite equation (1) as[7] :

$$(3)\quad V_t = D_t + \sigma\sqrt{\tau}\exp(-r\tau)\,[a_0 N(a_0) - a_1 N(a_1) + (1/\sqrt{2\pi})(\exp(-a_0^2/2) - \exp(-a_1^2/2))]$$

with $a_1 = [D_t\exp(r\tau) - X_t - \mu\tau] / (\sigma\sqrt{\tau})$

$a_0 = [- X_t - \mu\tau] / (\sigma\sqrt{\tau})$

$D_t = D_t\exp(r(\tau - t))$

and $N(h) = \int_{-\infty}^{h} (1/\sqrt{2\pi})\exp(-y^2/2)\, dy$

To the extent that the market value of the external debt is observable on the secondary market, equation (3) can be used in principle to determine the implicit value of the variable X_t. The problem is that, simultaneously, the volatility (σ) and the drift (μ) which characterize the process followed by this variable are also unknown. In order to solve this difficulty, we propose to follow an iterative approach which will be described in the next section.

Equation (3) identifies explicitly the factors driving the price of debt on the secondary market : the willingness to pay X_t, the actualization rate

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[7] The model can be applied to different maturities, e.g. short and long term debts. If the short term debt does not affect the probability of repayment of the long term debt at maturity, the market value of the debt is simply the sum of the market value of the short-term debt and of the long-term debt. The analysis can be extended to debt with n different maturities. By contrast, if the short -term debt influences the repayment prospect of the long-term debt, we should use bivariate or trivariate normal random variables approaches.

r_t, the maturity τ and the volume of debt D_t. The response of the market value of the debt to a variation in these variables can be examined using the above equation. For instance, an increase in X_t or in the drift μ will affect positively the market value of the debt. We will discuss more precisely on the sensitivity of the price of debt to changes in these factors in the empirical part of the paper. Rather, we prefer to focus on the impact of a debt-reduction policy on the price of debt, since this issue is extensively discussed in the recent literature related to the Brady Plan.

Differentiating equation (3), the effect of a change in the stock of external debt on the price of debt is the following:

$$(4)\quad \frac{\delta(V_t/D_t)}{\delta D_t} = \frac{[-V_t + D_t(1 + N(a_0) - N(a_1)]}{D^2_t} \quad > \text{or} < 0$$

The uncertainty about the sign of equation (4) reflects the opposing views which currently exist in the literature. For some authors, a debt relief includes a risk in the sense that the debtor may perceive this policy as a reward (see Corden, 1988), but according to others it may also facilitate the adjustment process of the debtor country (e.g Sachs, 1987). Equation (4) emphasizes that the impact of a variation in the stock of debt on the price of debt depends on some specific factors. Interestingly, the impact of a debt-relief is influenced by the volume of the external debt. The higher the stock of debt the more probable a debt-reduction will induce an increase in the price of debt, suggesting that the "debt overhang" is more likely to be reduced if the existing debt is large[8]. Also, a debt-reduction will generally raise the price of debt if the willingness to pay is high. Recently, Diwan and Rodrik (1991) argue that the central inefficiency created by the debt crisis is that the debtor countries cannot attract loans from new groups of creditors. A debt-reduction operation might be successful if it relaxes this liquidity constraint. But this supposes that the debtor country 's

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[8]The "debt overhang" is defined by Krugman (1987) as " the presence of an existing, inherited debt sufficiently large that creditors do not expect to be fully repaid".

creditworthiness is high enough to attract new financing.

Finally, given that the parameters of the stochastic process followed by the variable X_t are determined without any a priori assumption, it is interesting to test the capacity of prediction of the model. The expected value of X in period t' can be expressed as:

$$(5)\quad E(X_{t'}) = X_t + \mu T \qquad \text{where } T = t' - t \text{ and } t' > t$$

Using the Taylor formula of the second order, the expected value of the market value of the debt in period t' can be approximated as :

$$(6)\quad E(V_{t'}) = D_{t'} + \sigma\sqrt{\tau}\exp(-r\tau)\,[a'_0 N(a'_0) - a'_1 N(a'_1) + (1/\sqrt{2\pi})(\exp(-a'^2_0/2) - \exp(-a'^2_1/2)] + \exp(-r\tau)/(2\sqrt{2\pi\tau})\,(\exp(-a'^2_0/2) - \exp(-a'^2_1/2))(\sigma T)$$

with $a'_1 = [D_{t'}\exp(r\tau) - E(X_{t'}) - \mu\tau]/(\sigma\sqrt{\tau})$

$a'_0 = [-E(X_{t'}) - \mu\tau]/(\sigma\sqrt{\tau})$

Equation (6) indicates the expected value of the market value of the debt and, therefore, the price of debt.

2. An Empirical Test : Estimates and Simulations for 6 Highly Indebted Countries

The approach developed in the previous section, explicitly designed for empirical testing, is applied to six highly indebted countries - Argentina, Brazil, Chile, Mexico Poland and Venezuela - over the 1986:IV-90:IV period. The data on the maturity (τ), the interest rate (r_t) and the volume of debt (D_t) has been furnished by the Quarterly Review published by the Debt and International Finance Division of the World Bank. We also used the data published by Salomon Brothers for the price of debt. Note that we defined the

interest rate as the six-month Libor[9], the maturity (τ) as an average between the maturities of short-term and long term external debt and the volume of external debt as the total claims of commercial banks.

As mentioned in Section 1, if equation (3) can be used to derive the debtor country's willingness to pay (X_t), the difficulty is that the drift and the volatility of the process followed by this variable are also unknown. Recently, in order to solve this problem, Borensztein and Pennachi (1990) have proposed to express the volatility of X_t as a function of the instantaneous volatility of the price of debt. Their approach is however difficult to implement empirically since the instantaneous volatility of the price of debt is unobservable and cannot be considered constant over a period of time[10] and the drift of the state variable (μ) is not explicitly determined[11]. In such case, we prefer to use an alternative method which can be described as follows[12].

For a given country, we selected two arbitral initial values for the volatility and the drift. Under these conditions, we derived implicitly the values of X_t over a period of time using equation (3): X_1, X_2,...X_n where n is

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[9] By using the six-month Libor, we implicitly assume that the risk premium associated to the purchase of external debt assets on the secondary market is equal to 0.

[10] However, these two authors assume in their empirical work that this parameter is constant over sampling periods when, in fact, it was changing.

[11] In their empirical test, Borensztein and Pennachi assume that the value of the drift ranges from 0 to 0.09. According to these authors, the first value "implies that the expected rate of change of the state variable equals the expected rate of return on a marketable asset with the same risk", and the second value is an approximation for the case in which "the expected rate of growth of the state variable is zero" (p.814).

[12] Several approaches can be proposed in order to determine empirically the drift and the volatility of the process followed by the willingness to pay. For instance, the drift could be approximated by average GDP growth or the openness of the debtor country's economy over the period since these factors might be correlated to the average willingness to pay as suggested by some authors (e.g. Diwan (1990)).

the number of observations. Given these estimated values, we calculated a new value for the drift ($\mu = E\Delta X_t/\Delta t$) and for the volatility ($\sigma^2 = E(\Delta X_t - \mu\Delta t)/\Delta t$) which can be compared to their initial values. To the extent that the initial and final values do not differ the process was stopped. In the opposite case, we started again the process with new initial values. While this iterative methodology is not entirely defensible[13], it presents the main advantage to determine the values of X_t, the drift and the volatility without any a priori assumption on the variables which can influence the stochastic process.

Table 1 summarizes our main findings. Note that the values of the willingness to pay (in US$ billion) over the observation period are presented in Annex I. The drift (μ) and the volatility (σ) indicate the characteristic of the process followed by the willingness to pay over the 1986-90 period for each country of our sample. The parameter ß shows the correlation between the price of debt and the willingness to pay over the observation period. We also present the probability of full default (p_0) and the probability of partial default (p_1) for each country. In order to test the model out of sample, the expected price of debt for the first quarter of 1991 (EP_{t+1}) is compared to the observed value (P_{t+1}). Finally, as an illustration, we present the impact of a 10% debt-relief on the expected price of debt ($E(P_{t+1})^*$).

The results indicate that the willingness to pay were quite volatile in all countries during the last four years. This reflects the unstable conditions which existed and continue to exist in most of the highly indebted countries. The parameter ß shows that the changes in the values of the country's creditworthiness are different from the variations in the price of debt. This results from the influence of the average maturity, the interest rate, the drift and the volatility on the price of debt. Interestingly, the probability of full default appears higher in Argentina, Poland and Venezuela

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[13]In particular, we do not provide an analytical solution. Moreover, as the existence of multiple solutions cannot be a priori rejected, we needed to test the iterative method for a large range of initial values. Fortunately, we did not find any multiple solutions.

than in Mexico, Chile and Brazil. The recent favorable economic results of Mexico and Chile explain the highest creditworthiness of these two countries. In the case of Brazil, while the probability of full default is relatively low, the probability of partial default seems high. Because the Brazil's stock of debt is very important, it is unlikely that this country will call a total default on its debt in spite of its poor economic performance. Also, we tried to examine how well the model works out of sample to test its robustness. Using equation (6) we calculated the expected value of the price of debt for the first quarter of 1991. The results are encouraging in the sense that the difference between both values of the price of debt are in general small. The impact of a 10 percent debt-reduction has also been examined for our sample of highly indebted countries. If the impact of such policy was ambiguous in the theoretical model, all simulation results indicate that the effect of a decline in the stock of external debt would increase the price of debt on the secondary market.

Finally, the short-run sensitivity of the price of debt to changes in the rate of interest rate and in maturity can also be examined. As an illustration, we present the results in the case of Argentina assuming that the initial price of debt was US$ 0.216 in all simulations. First, a two years increase in the maturity leads to a decline in the price of debt from US$ 0.216 to US$ 0.165. This reflects the fact that the willingness to pay will decrease over time because the drift is negative in the case of Argentina. Second, the price of debt is positively influenced by a decline in the rate of interest. As a matter of fact, a reduction in the interest rate of one percent would increase the price of debt to US$ 0.23. The dramatic decline in the Libor rate explains to a large extent the higher prices of debt observed on the secondary market since the beginning of 1991.

3. The determinants of willingness to pay

In the previous section, we emphasized the impact of changes in the volume of debt, in average maturity and in the interest rate on the price of debt. This analysis shed light on the implications of debt-reduction programs

(which the above variables are the essential components) on the probability of payment of the debtor country. But this probability may be influenced by some additional factors. The purpose in this section is to determine the economic and political variables which can affect the changes in the willingness to pay and, consequently, in the price of debt. The procedure used in this paper differs from other studies in that the dependent variable is the willingness to pay rather than the price of debt. Using the willingness to pay, the sensitivity of the risk of default to changes in the volatility, the average maturity and the interest rates is controlled for, implying more reliable tests of the impact of external factors[14]. In other words, we assume that the price of debt is indirectly influenced by some factors through their impact on the willingness to pay. Note that we define the willingness to pay per dollar of external debt (X_t/D_t) as the dependant variable. Our estimated results can be compared with other studies which used the price of debt as the dependant variable (e.g Boehmer and Megginson (1990)).

The responsiveness of the willingness to pay (per dollar of external debt) to three classes of factors has been estimated. First, we tested the hypothesis that the willingness to pay are influenced by the debtor country's capacity to pay. Identification of such domestic influences, if any, on the willingness to pay may confirm that debtor countries economic situation is partly reflected in the price of debt. We used the economic characteristics of borrowers which have been employed in a wide range of empirical studies concerning developing country debt and the price of debt. These variables are: GDP, GDP growth, exports, imports, variation in reserves, inflation, and the degree of openness of the country. Second, as recently suggested by Stone (1991), the impact of particular events on the willingness to pay may be

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[14]More broadly, this approach can be compared to the studies which (i) examined the characteristics of debtor countries which presage rescheduling of their debt and (ii) the determinants of the interest premium (spread) charged on LDC loans by international commercial banks. But, these two approaches have been extensively criticized since both rescheduling and the spread above the LIBOR cannot be considered as good proxies of the probability of default of the debtor country. "The fundamental difficulty with these models is defining appropriately the dependant variable, the occurrence of a debt problem" (Gersovitz, Eaton and Stiglitz (1986), p.506).

significant since the number of potential buyers and sellers are small in the secondary market. In order to test this hypothesis, we examine the effects of the increase in commercial bank loan reserves in mid-1987 and the announcement of the Brady Plan in March 1989. Third, since the economic conditions existing in the creditor country can influence the bargaining process between the debtor and the creditors, we estimated the impact of changes in US industrial production index on the willingness to pay of the debtor country.

The impact of the above factors on the willingness to pay was estimated using pooled cross-section time-series data for 6 countries described in Section 2 over the 1986:4 - 1990:4 period. We used the typical random-effect error components equations since simply pooling the data and estimating by an ordinary least squares procedure can result in inefficiency as well as several sorts of biases due to heterogeneity of coefficients across countries and time [15]. The data was obtained from the IMF's International Financial Statistics and from various national sources. For some countries, because quarterly data on GDP was not available, we used the Industrial Index.

The estimated results are summarized in **Table 2**. On the whole, the results appear quite robust. The most interesting aspect of these results concerns the positive impact of changes in the debtor country's capacity of payment on the willingness to pay. Indeed, an increase in GDP or GDP growth appear to influence positively the dependant variable. This result seems to indicate that GDP and GDP growth are good indicators of the willingness to pay. Similarly, an increase in the change of international reserves and in exports leads to an improvement of the debtor country willingness to pay. Note, however, that the impact of a change in reserves is positive but not statistically significant in most regressions. As suggested by several authors (e.g. Diwan (1990)), a higher degree of openness of the debtor country (measured as the ratio of imports and exports over GDP) leads to an

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[15] The fixed-effect error component model and regressions for individual countries were also tested. Overall, the results were not qualitively very different from those presented in Table 2. Note, however, that the degree of freedom is low for individual regressions. These results can be obtained from the authors upon request.

increase in the willingness to pay. In such a case, the creditor can use a larger range of sanctions in case of non-payment.

The results pertaining to the other variables also deserves a brief explanation. The impact of Brady Plan announcement in March 1989 exerted a positive and significative impact on the debtor countries willingness to pay. As the eventual participation in a debt-reduction operation was reserved to countries with satisfying results, such announcement increased the debtor countries willingness to pay. As expected, the impact of the increase in loan reserves of commercial banks in mid-1987 was negative on the willingness to pay. Such increase in reserves is likely to reduce the probability to be penalized in case of partial payments. Finally, the willingness to pay appears to be sensitive to changes in US aggregates and in particular to the US industrial production index. The estimated negative parameter associated to this variable indicates that an improvement in the US economy can ameliorate the commercial banks position, thereby reducing the penalties associated to default on LDCs external debt.

4. Conclusion

We proposed in this paper a new theoretical approach in order to determine the debtor country's willingness to pay and hence the price of debt on the secondary market of highly indebted countries. We assumed that the market value of the debt can be viewed as an option where the country examines the alternative to pay according to the values of its potential payments and its willingness to pay. Using the option-pricing theory, we measured the willingness to pay of six highly indebted countries over the last five years without any a priori assumption regarding the factors which can influence this variable. Since the drift and the volatility of the willingness to pay have been identified, the model was used to determine the future price of debt. The comparison between the observed and the estimated price of debt for the first quarter of 1991 indicates that the model predicted relatively well the future price of the debt. The sensitivity of the price of debt to changes in the volume of debt, the average maturity and the interest rate was also examined.

This exercise shed light on the eventual implications of debt-reduction operations on the price of debt. Finally, we attempted to determine empirically the influence of various factors on the willingness to pay. We emphasized that indicators of the debtor country's capacity of payment and particular events such as an increase in commercial banks loan reserves can influence significantly the willingness to pay and, consequently, the price of debt.

Although the approach presented in this paper can be extended in various ways - e.g. a stochastic interest rate can be introduced or different classes of debt should be distinguished according to their maturities - the policy implications of the exercise are straightforward.

(1) A debt-reduction operation is likely to influence positively the price of debt on the secondary market. Specifically, the model demonstrates that this positive impact is closely related to the initial levels of debt and of the wilingness to pay of the debtor country. While the first point indicates that the "debt overhang" is more likely to be reduced if the existing debt is large, the second suggests that the benefit of a debt-reduction operation will be greater whether the debtor country's willingness is high enough to attract new financing.

(2) An increase in GDP of the debtor country may exert a significative impact on the its willingness to pay external debt. An improvement in economic conditions of the debtor country can therefore enhance payments of interest on external debt. This suggests that a strategy relying on debtor country's economic growth may be more efficient than the implementation of penalties for default.

(3) Changes in creditor's behavior may affect the debtor country's willingness to pay. While the Brady announcement produced a favorable impact on the willingness to pay, the influence of announcements regarding loans reserves by commercial banks was negative.

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Table 1:

Main Indicators

Country	ARGENTINA	BRAZIL	CHILE	MEXICO	POLAND	VENEZUELA
μ(%)	-10.2	-5.8	-0.3	-5.00	-15.4	-3.51
σ(%)	27.5	24.0	34.4	34.8	35.9	19.27
ß	0.874	0.394	0.774	0.434	0.950	0.919
P_0(%)	61.8	39.4	11.7	30.9	58.6	63.2
P_1(%)	93.8	97.9	43.8	71.7	98.5	76.7
$E(P_{t+1})$	21.6	23.3	74.0	45.9	15.8	53.4
P_{t+1}	18.7	27.7	76.0	47.3	19.73	54.8
$E(p_{+1})$*	23.0	25.57	75.7	48.1	17.3	55.4

Note : μ = drift of the willingness to pay, σ = the volatility of the willingness to pay, ß the correlation between the price and the willingness to pay, P_0 = the probability of full default, P_1 = the probability of full and partial default, $E(P_{t+1})$ = the expected price of debt for the first quarter of 1991, P_{t+1} the observed price of debt for the first quarter of 1991 and (EP_{t+1}) = the expected price of debt assuming a debt-reduction of 10% for the first quarter of 1991.*

Table 2:

Estimates (1986:4 - 1990:4)

The Determinants of Willingness to Pay

(t-statistics in parenthesis)

Independent Variables	Equations				
	(1)	(2)	(3)	(4)	(5)
constant	0.140	0.131	0.161	0.174	0.159
	(4.49)	(4.40)	(4.62)	(5.12)	(5.63)
(variation in	$0.131\ 10^{-3}$	$0.101\ 10^{-3}$	$0.142\ 10^{-3}$	$0.08\ 10^{-4}$	$0.860\ 10^{-4}$
reserves)/GDP	(1.47)	(1.14)	(1.53)	(0.83)	(1.04)
GDP	$0.151\ 10^{-2}$	$0.143\ 10^{-2}$	$0.135\ 10^{-2}$		$0.151\ 10^{-2}$
	(4.31)	(4.19)	(3.57)		(4.68)
GDP growth				0.096	
				(1.51)	
exports/GDP	$0.671\ 10^{-3}$		$0.684\ 10^{-3}$	$0.170\ 10^{-3}$	
	(2.22)		(2.33)	(0.59)	
U.S. Industrial	$-0.327\ 10^{-2}$	$-0.311\ 10^{-2}$	$-0.339\ 10^{-2}$	$-0.233\ 10^{-2}$	$-0.417\ 10^{-2}$
index	(-4.36)	(-4.15)	(-4.31)	(-3.03)	(-5.39)
degree of openness		0.332 10-3			0.411 10-3
		(1.79)			(2.26)
inflation			0.110		
			(0.24)		
Brady Announcement					$0.191\ 10^{-1}$
					(2.09)
Reserves Announcement					$-0.357\ 10^{-1}$
					(-2.82)
SSR	0.089	0.089	0.092	0.106	0.076

Annex :

The Evolution of the Willingness to Pay, 1986:4-1990:4
In US$ Million

Dates	Argentina	Brazil	Chile	Mexico	Poland	Venezuela
1986.4	87.42	184.86	18.04	103.89	12.91	40.13
1987.1	93.76	163.58	18.96	113.89	13.44	43.76
1987.2	84.26	154.51	20.85	132.75	13.53	46.66
1987.3	74.78	112.85	13.32	91.88	13.18	36.65
1987.4	86.45	129.40	17.57	139.25	14.31	44.04
1988.1	71.09	131.01	14.76	111.28	13.89	36.94
1988.2	66.99	145.91	17.11	118.36	13.44	38.39
1988.3	69.83	157.82	17.53	126.42	12.67	36.96
1988.4	69.83	161.96	15.67	112.58	12.04	32.28
1989.1	65.13	145.59	16.14	108.11	11.60	28.95
1989.2	54.47	153.03	17.43	105.63	12.45	31.51
1989.3	60.24	132.09	14.96	96.05	12.11	30.63
1989.4	43.64	102.34	12.81	74.56	6.55	25.32
1990.1	34.32	120.55	15.45	65.03	5.02	27.24
1990.2	34.32	108.66	14.35	73.20	5.80	31.22
1990.3	36.26	101.59	16.15	63.88	5.70	30.09
1990.4	52.06	105.16	18.28	71.25	6.24	39.10

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